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10/573,239	03/22/2006	Artemi Martsinovsky	12096.PCT.US	7195

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EXAMINER	
KIM, JAY C	

ART UNIT	PAPER NUMBER
2815	

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Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Office Action Summary	Application No.	Applicant(s)	
	10/573,239	MARTSINOVSKY ET AL.	
	Examiner	Art Unit	
	JAY C. KIM	2815	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE *3* MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *19 February 2009*.

2a)☒ This action is **FINAL**. 2b)☐ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *1,3-8,10-19 and 21* is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *1,3-8,10-19 and 21* is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☒ The drawing(s) filed on *08 September 2008* is/are: a)☒ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☒ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☒ All b)☐ Some * c)☐ None of:

1.☒ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☐ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☐ Information Disclosure Statement(s) (PTO/SB/08) Paper No(s)/Mail Date _____.
4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____ .
5) ☐ Notice of Informal Patent Application
6) ☐ Other: _____.

DETAILED ACTION

This Office Action is in response to Amendment filed February 19, 2009.

Claim Objections

1. Claims 4 and 6 are objected to because of the following informalities:

On line 3 of claim 4, “electrode” should be inserted after "emitter".

On line 1 of claim 6, “any” should be removed.

Appropriate correction is required.

Claim Rejections - 35 USC § 102

2. The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

> A person shall be entitled to a patent unless –
>
> (b) the invention was patented or described in a printed publication in this or a foreign country or in public use or on sale in this country, more than one year prior to the date of application for patent in the United States.

3. Claims 1, 3, 5, 10-14, 16 and 21 are rejected under 35 U.S.C. 102(b) as being anticipated by Cox (US 6,064,137).

Regarding claims 1, 5 and 21, Cox discloses a tunnel diode (Figs. 1g and 5) comprising an emitter electrode (4 or composite layer of 4 and 6) (col. 8, lines 24-25 and 30-31), wherein the emitter electrode (4 or composite layer of 4 and 6) comprises a metal (4), a collector electrode (composite layer of 8 and 6) (col. 8, lines 27-28), separated from the emitter electrode (4 or composite layer of 4 and 6) by a gap, the collector electrode (composite layer of 8 and 6) comprising of a band gap material (6), the band gap material (6) being a crystal material having filled zero temperature valence

band and empty conductive band, wherein the band gap material (6) is a diamond material, and the gap contains only a vacuum (col. 8, lines 54-55) and a work function of the collector electrode (work function of layer 6) is equal to a work function of the emitter electrode (work function of layer 6) (claims 1 and 5), and in which the emitter electrode (4 or composite layer of 4 and 6) has a layer of band gap material (6) deposited thereupon (claim 21).

Regarding claim 3, Cox further discloses that the collector electrode (composite layer of 8 and 6) comprises a metal (8) (col. 10, lines 44-45) having a layer of band gap material (6) deposited thereupon.

Regarding claims 10 and 11, Cox discloses a vacuum diode heat pump (Fig. 5) comprising the tunnel diode of claim 1 (col. 11, lines 24-29) (claim 10), and a heat to electricity converter (Fig. 5) comprising the tunnel diode of claim 1 (col. 7, lines 54-55) (claim 11).

Regarding claims 12 and 16, Cox discloses a method for promoting tunneling of electrons having an energy level higher than the Fermi level of an emitter electrode (composite layer of 4 and 6 in Figs. 1g and 5) (col. 8, lines 24-25 and 30-31) from an emitter electrode surface wherein the emitter electrode (composite layer of 4 and 6) comprises a metal (4), comprising the step of positioning a collector electrode (composite layer of 8 and 6) (col. 8, lines 27-28) comprising a band gap material (6), which is a diamond material, at a distance within a tunneling range of the electrons, which is inherent for the tunneling gap diode (Fig. 1g and 5) to operate, the band gap material (6) being a crystal material having filled zero temperature valence band and

empty conductive band, wherein the emitter electrode (composite layer 4 and 6) is separated from the collector electrode (composite layer of 8 and 6) by a gap, the gap containing only a vacuum (col. 8, lines 54-55) and wherein a work function of the collector electrode (work function of layer 6) is equal to a work function of the emitter electrode (work function of layer 6).

Regarding claim 13, Cox discloses a method for suppressing back tunneling of electrons in a tunnel diode (Figs. 1g and 5) comprising the step of coating a collector electrode (8) (col. 8, lines 27-28) with a layer of a band gap material (6) (col. 8, lines 30-31), the band gap material (6) being a crystal material having filled zero temperature valence band and empty conductive band, and the collector electrode (8) being separated from an emitter electrode (composite layer of 4 and 6) (col. 8, lines 24-25) by a gap, the emitter electrode (composite layer of 4 and 6) comprising a metal (4) and the gap containing only a vacuum (col. 8, lines 54-55) wherein a work function of the collector electrode (work function of layer 8 formed of Ni) (col. 10, lines 44-45) is equal to a work function of the emitter electrode (work function of layer 4 formed of Ni).

Regarding claim 14, Cox further discloses for the method of claim 12 that the collector electrode (composite layer of 8 and 6) comprises a layer of band gap material (6) deposited on a metal collector (8).

Claim Rejections - 35 USC § 103

4. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and

> the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

5. Claims 1, 3-6 and 10-17 are rejected under 35 U.S.C. 103(a) as being unpatentable over Bell (US 4,280,074).

Regarding claims 1, 5 and 6, Bell discloses a tunnel diode (Figs. 2 and 8) comprising an emitter electrode (35) (col. 4, line 59), a collector electrode (composite layer of 25-28) (col. 3, lines 55-62), separated from the emitter electrode (35) by a gap, the collector electrode (composite layer of 25-28) comprising a band gap material (composite layer of 25-27), the band gap material being a crystal material having filled zero temperature valence band and empty conductive band, wherein the band gap material (composite layer of 25-27) is a semiconductor such as GaAs (col. 4, lines 60-62), and the gap may contain only a vacuum (col. 4, lines 58-59) and wherein a work function of the collector electrode (work function of layer 25) is less than a work function of the emitter electrode (35) due to an applied work function lowering activator (col. 2, lines 10-13).

Bell differs from the claimed invention by not showing that the emitter electrode comprises a metal.

It would have been obvious, if not inherent, to the one of ordinary skill in the art at the time the invention was made that the emitter electrode disclosed by Bell may comprise a metal, because a metal is commonly used as an emitter electrode material to release electrons.

Regarding claims 3 and 4, Bell further discloses that the collector electrode (composite layer of 25-28) comprises a metal (28) having a layer of band gap material

(composite layer of 25-27) deposited thereupon (claim 3) in which the layer of band gap material (composite layer of 25-27) has a thickness (col. 4, lines 62-63) greater than the mean distance of relaxation of electrons tunneling from the emitter electrode (35) (claim 4).

Regarding claims 10 and 11, Bell discloses a vacuum diode heat pump (Fig. 8) comprising the tunnel diode of claim 1, because heat is transferred from the heat source (37) to the heat sink (38) by electron emission from the emitter (35) (claim 10), and a heat to electricity converter (Fig. 8) comprising the tunnel diode of claim 1, because electrons are emitted from the emitter (35) in contact with the heat source (37) (claim 11).

Regarding claims 12, 16 and 17, Bell discloses a method for promoting tunneling of electrons having an energy level higher than the Fermi level of an emitter electrode (35 in Fig. 8) (col. 4, line 59) from an emitter electrode surface, comprising the step of positioning a collector electrode (composite layer of 25-28 in Fig. 2) (col. 3, lines 55-62) comprising a band gap material (composite layer of 25-27) at a distance within a tunneling range of the electrons, the band gap material (composite layer of 25-27) being a crystal material having filled zero temperature valence band and empty conductive band, wherein the band gap material (composite layer of 25-27) is a semiconductor such as GaAs (col. 4, lines 60-62), and the emitter electrode (35) is separated from the collector electrode (composite layer of 25-28) by a gap, the gap containing only a vacuum (col. 4, lines 58-59) and wherein a work function of the collector electrode (work

function of layer 25) is less than a work function of the emitter electrode (35) due to an applied work function lowering activator (col. 2, lines 10-13).

Bell differs from the claimed invention by not showing that the emitter electrode comprises a metal.

It would have been obvious, if not inherent, to the one of ordinary skill in the art at the time the invention was made that the emitter electrode disclosed by Bell may comprise a metal, because a metal is commonly used as an emitter electrode material to release electrons.

Regarding claim 13, Bell discloses a method for suppressing back tunneling of electrons in a tunnel diode (Figs. 2 and 8) comprising the step of coating a collector electrode (25) (col. 3, lines 55-62) with a layer of a band gap material (26), the band gap material (26) being a crystal material having filled zero temperature valence band and empty conductive band, and the collector electrode (25) being separated from an emitter electrode (35) (col. 4, line 59) by a gap, the gap containing only a vacuum (col. 4, lines 58-59) wherein a work function of the collector electrode (25) is less than a work function of the emitter electrode (35) due to an applied work function lowering activator (col. 2, lines 10-13).

Bell differs from the claimed invention by not showing that the emitter electrode comprises a metal.

It would have been obvious, if not inherent, to the one of ordinary skill in the art at the time the invention was made that the emitter electrode disclosed by Bell may

comprise a metal, because a metal is commonly used as an emitter electrode material to release electrons.

Regarding claims 14 and 15, Bell further discloses for the method of claim 12 that the collector electrode (composite layer of 25-28) comprises a layer of band gap material (composite layer of 25-27) deposited on a metal collector (28) (claim 14) in which the layer of band gap material (composite layer of 25-27) has a thickness (col. 4, lines 62-63) greater than the mean distance of relaxation of electrons tunneling from the emitter electrode (35) (claim 15).

6. Claims 7, 8, 18 and 19 are rejected under 35 U.S.C. 103(a) as being unpatentable over Cox (US 6,064,137) in view of Tavkhelidze et al. (US 6,417,060). The teachings of Cox et al. are discussed above.

Regarding claims 7, 8, 18 and 19, Cox differs from the claimed invention by not showing that the gap is in the range 1-100nm (claims 7 and 18), and the gap is in the range 1-10nm (claims 8 and 19).

Tavkhelidze et al. disclose a tunnel diode (Fig. 2) comprising an emitter electrode (5) (col. 3, line 33) and a collector electrode (1) (col. 3, line 35), wherein the emitter electrode (5) and the collector electrode (1) are separated by a gap in the range 50 nm or less, preferably 5 nm or less (lines 9-12 of ABSTRACT).

Since both Cox and Tavkhelidze et al. teach a tunnel diode, it would have been obvious to the one of ordinary skill in the art at the time the invention was made that the emitter electrode and the collector electrode disclosed by Cox may be separated by a gap in the range disclosed by Tavkhelidze et al., for example, ~50 nm or ~ 5 nm,

because a gap distance between an emitter electrode and a collector electrode in a tunnel diode can be varied to control electron tunneling and thus the performance of the tunnel diode.

Further regarding claim 7, 8, 18 and 19, the claims are prima facie obvious without showing that the claimed ranges of the gap achieve unexpected results relative to the prior art range. *In re Woodruff*, 16 USPQ2d 1935, 1937 (Fed. Cir. 1990). See also *In re Huang*, 40 USPQ2d 1685, 1688 (Fed. Cir. 1996) (claimed ranges of a result effective variable, which do not overlap the prior art ranges, are unpatentable unless they produce a new and unexpected result which is different in kind and not merely in degree from the results of the prior art). See also *In re Boesch*, 205 USPQ 215 (CCPA) (discovery of optimum value of result effective variable in known process is ordinarily within skill of art) and *In re Aller*, 105 USPQ 233 (CCPA 1955) (selection of optimum ranges within prior art general conditions is obvious).

7. Claims 7, 8, 18 and 19 are rejected under 35 U.S.C. 103(a) as being unpatentable over Bell (US 4,280,074) in view of Tavkhelidze et al. (US 6,417,060). The teachings of Bell et al. are discussed above.

Regarding claims 7, 8, 18 and 19, Bell differs from the claimed invention by not showing that the gap is in the range 1-100nm (claims 7 and 18), and the gap is in the range 1-10nm (claims 8 and 19).

Tavkhelidze et al. disclose a tunnel diode (Fig. 2) comprising an emitter electrode (5) (col. 3, line 33) and a collector electrode (1) (col. 3, line 35), wherein the emitter

electrode (5) and the collector electrode (1) are separated by a gap in the range 50 nm or less, preferably 5 nm or less (lines 9-12 of ABSTRACT).

Since both Bell and Tavkhelidze et al. teach a tunnel diode, it would have been obvious to the one of ordinary skill in the art at the time the invention was made that the electrodes disclosed by Bell may be separated by a gap in the range disclosed by Tavkhelidze et al., for example, ~ 50 nm or ~ 5 nm, because a gap distance between electrodes in a tunnel diode can be varied to control electron tunneling and thus the performance of the tunnel diode.

Further regarding claim 7, 8, 18 and 19, the claims are prima facie obvious without showing that the claimed ranges of the gap achieve unexpected results relative to the prior art range. *In re Woodruff*, 16 USPQ2d 1935, 1937 (Fed. Cir. 1990). See also *In re Huang*, 40 USPQ2d 1685, 1688 (Fed. Cir. 1996) (claimed ranges of a result effective variable, which do not overlap the prior art ranges, are unpatentable unless they produce a new and unexpected result which is different in kind and not merely in degree from the results of the prior art). See also *In re Boesch*, 205 USPQ 215 (CCPA) (discovery of optimum value of result effective variable in known process is ordinarily within skill of art) and *In re Aller*, 105 USPQ 233 (CCPA 1955) (selection of optimum ranges within prior art general conditions is obvious).

Double Patenting

13. The nonstatutory double patenting rejection is based on a judicially created doctrine grounded in public policy (a policy reflected in the statute) so as to prevent the unjustified or improper timewise extension of the "right to exclude" granted by a patent and to prevent possible harassment by multiple assignees. A nonstatutory obviousness-type double patenting rejection is appropriate where the conflicting claims

are not identical, but at least one examined application claim is not patentably distinct from the reference claim(s) because the examined application claim is either anticipated by, or would have been obvious over, the reference claim(s). See, e.g., *In re Berg*, 140 F.3d 1428, 46 USPQ2d 1226 (Fed. Cir. 1998); *In re Goodman*, 11 F.3d 1046, 29 USPQ2d 2010 (Fed. Cir. 1993); *In re Longi*, 759 F.2d 887, 225 USPQ 645 (Fed. Cir. 1985); *In re Van Ornum*, 686 F.2d 937, 214 USPQ 761 (CCPA 1982); *In re Vogel*, 422 F.2d 438, 164 USPQ 619 (CCPA 1970); and *In re Thorington*, 418 F.2d 528, 163 USPQ 644 (CCPA 1969).

A timely filed terminal disclaimer in compliance with 37 CFR 1.321(c) or 1.321(d) may be used to overcome an actual or provisional rejection based on a nonstatutory double patenting ground provided the conflicting application or patent either is shown to be commonly owned with this application, or claims an invention made as a result of activities undertaken within the scope of a joint research agreement.

Effective January 1, 1994, a registered attorney or agent of record may sign a terminal disclaimer. A terminal disclaimer signed by the assignee must fully comply with 37 CFR 3.73(b).

14. Claims 1, 3-8, 10-19 and 21 are provisionally rejected on the ground of nonstatutory obviousness-type double patenting as being unpatentable over claims 1-9 and 11-15 of copending Application No. 11/392,182. Although the conflicting claims are not identical, they are not patentably distinct from each other because claims 1-9 and 11-15 of Application No. 11/392,182 include all the recited limitations of claims 1, 3-8, 10-19 and 21 of current Application. This is a provisional obviousness-type double patenting rejection because the conflicting claims have not in fact been patented.

Response to Arguments

8. Applicants' arguments with respect to rejection of claims 1, 12 and 13 under 102(b) as being anticipated by Cox have been considered but are moot in view of the new ground of rejection using an alternate interpretation.

9. Applicants' arguments filed February 19, 2009 have been fully considered but they are not persuasive.

Applicants argue that "in the current invention the collector electrode has a work function that is less than *or equal to* the work function of the emitter electrode", and that "this cannot be the case in the prior art of Bell where the work function of the collector electrode is almost zero and the emitter electrode, assuming it is a metal in accordance with Examiner's interpretation, must by definition have a higher work function than the collector electrode". Applicants' latter argument is contradictory to the former argument.

Applicants argue that "furthermore, for the sake of completeness, Applicant does not believe that it would be obvious and without requiring undue experimentation to modify Cox in such a way as to yield an inter-electrode separation of the order of 1-100 nm (claims 7 and 18) or 1-10 nm (claims 8 and 19)", that "Cox's preferred embodiment has an inter-electrode separation of 500 nm (Col. 9, line 51) and Cox states that an inter-electrode separation of 100 nm is difficult to manufacture (end of col. 11 and beginning of col. 12)", that "this is partly due to the difficulty of manufacturing spacers of such dimensions", that "this difficulty is not overcome in Tavkhelidze who rather uses a sacrificial layer to maintain electrode separation", and that "Tavkhelidze makes no contribution to solving the problem of manufacturing spacers on a 1-100 nm scale". These arguments are not relevant to current prior art rejections, because Cox clearly discloses that "the space between the cathode and anode will typically be very small, and for the purposes of the preferred embodiment, a spacing of 0.5 μm is specified", and the Examiner used a gap between the two diamond material layers 6 not a gap between the cathode 4 and the anode 8. Therefore, Applicants did not provide any

evidence that the gap between the two diamond material layers 6 disclosed by Cox may not fall within the claimed ranges as disclosed by Tavkhelidze et al.

Applicants argue that "thus Applicant believes that it would not be obvious or trivial to modify Cox's invention in light of Tavkelidze [sic] to give an inter-electrode separation on the scale disclosed in claims 7, 8, 18 and 19". See above response.

Conclusion

10. Applicants' amendment necessitated the new ground of rejection presented in this Office action. Accordingly, **THIS ACTION IS MADE FINAL**. See MPEP § 706.07(a). Applicants are reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire THREE MONTHS from the mailing date of this action. In the event a first reply is filed within TWO MONTHS of the mailing date of this final action and the advisory action is not mailed until after the end of the THREE-MONTH shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the date of this final action.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to JAY C. KIM whose telephone number is (571)270-1620. The examiner can normally be reached on 7:30 AM - 5:00 PM EST.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Kenneth Parker can be reached on (571) 272-2298. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

/J. K./
Examiner, Art Unit 2815
April 13, 2009

/Jerome Jackson Jr./
Primary Examiner, Art Unit 2815